Multi-scale modeling of deformation and contraction of blood clots

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Thromboembolism, one of the leading causes of morbidity and mortality worldwide, is characterized by formation of obstructive intravascular clots (thrombi) and their mechanical breakage (embolization). A novel two-dimensional multi-phase computational model will be described that simulates active interactions between the main components of the blood clot, including platelets and fibrin. Simulations provide new insights into mechanisms underlying clot stability and embolization that cannot be studied experimentally at this time. In particular, multi-phase model simulations, calibrated using experimental intravital imaging of an established arteriolar clot, show that flow-induced changes in size, shape and internal structure of the clot are largely determined by two shear-dependent mechanisms: reversible attachment of platelets to the exterior of the clot and removal of large clot pieces [1]. Role of platelets-fibrin network mechanical interactions in determining shape of a clot and clot contraction will be also discussed and quantified using analysis of experimental data [2,3]. These results can be used in future to predict risk of thromboembolism based on the patient specific data about composition, permeability and deformability of a clot formed from patient's blood in a microfluidic device under specific local hemodynamic conditions. Finally, general approach of combining multi-scale modeling and machine learning approaches will be also discussed.

References

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